



RESEARCH ARTICLE

THE EFFECT OF CLIMATE FACTORS ON THE NUMBER AND DEVELOPMENT OF DIFFERENT AGED YOUTH OF PURE FIR (*ABIES NORDMANNIANA* SUBSP. *BORNMÜLLERIANA* MATTF.) FORESTS OF BARTIN-KUMLUCA REGION

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ABSTRACT

Natural resources have been constantly destroyed from the time of mankind until the present day. This has led to gradual deterioration of the ecological balance. Particularly the benefits realized in order to meet the needs of energy, housing and nutrition have led to irreparable impairments in all natural resources and the structure of natural populations and gene frequency have changed in the negative direction. These negativities have also reduced the biological diversity of all living things. Today, the widespread industry and the environmental problems that arise in the face of the growing population have led to the end of the natural resources. In particular, with the emergence of climate change problems, it has become very difficult to ensure the sustainability of natural resources. Forests, one of the most important sources of nature from these negativities, have also been damaged. Ensuring the sustainability of forests is very important in terms of global warming and carbon emissions. For this reason, successful natural and artificial rejuvenation work is necessary in the forests. For this purpose, the natural structure of the forests, the developmental dynamics of the forests and especially the influence of the climate factors on young individuals need to be analyzed and evaluated very well. It is essential that any technical interventions to be carried out in the forests are dealt with in detail in terms of microecological conditions. For this purpose, changes in number of natural fir youth and their growth status were investigated in the fixed test sites of 10x25x40 m size between 2004 and 2017 on the stems of *Abies nordmanniana* subsp. *bornmülleriana* Matff., Which is naturally found in the Bartın-Ardıç region. As a result of these examinations, it was determined that the average number of youth per square meter between 2004 and 2017 showed a significant decreasing trend, ranging from 286.7 to 36.4. On the other hand, between the same years, it has been determined that the mean height growth of the fir juvenilities changes between 1.2-83.6 cm in normal closure conditions and shows trend. In addition, it has been determined that the root collar diameter measurements made on natural juvenilities in the sample plots showed trend between 1.3-18.7 mm. The standardized rainfall-evapotranspiration index (SPEI) was used to determine how the juvenilities affected the climate conditions in the study. As a result of the climate analysis, it has been found that the number of natural fir juvenilities and their growth performance are significantly affected negatively from the drought periods in the region and they are far below the normal performance level when growing in these periods. However, the drought periods between 2004 and 2017 have also significantly delayed the maturation of the stand.

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INTRODUCTION

It's possible to see different forest organizations and stand structures shaped by the effect of different ecological conditions in nature. For manage of these forest forms and structures, different management models are applied according to the biology of the species, technical, economic, and ecological purposes. Some of these management models are suitable for operating with cutting area method, while others especially suited to the species in terms of their biology and silvicultural characteristics (Saatçioğlu, 1976). For reducing the impact of storms, snow, insects and bacteria damages, different forests have important advantages due to the high degree of neighborly relations (Ata, 1995). Within this scope, the stands that are the able to withstand the shade for a long time and have important advantages in terms of rejuvenation

ecology exhibit a structure suitable for different organization (Yılmaz et al., 2012). Turkey is home of the 4 fir species that have different silvicultural characteristics. These species of firs form highly valuable pure and mixed stands in natural propagation areas (Yalırık, 1993). Only the Kazdağı Fir (*Abies equi-trojani* Ascher et Sinten) grows fast because it's hybrid. This fir is not suitable to different aged management models like other 3 fir species (Asan, 1984). But global climate change threatening to development of trees and stands' health. This threat affects the generation circle and risk the continuity of species. Therefore climate change and effects were monitored continuous, especially on young tree populations.

**Aim of Study:** Ensuring the continuity of forests is very important in terms of global warming and carbon emissions. Therefore, successful natural and artificial rejuvenation is very important. For this purpose, the natural structure of forests, development dynamics of the species and especially the effects

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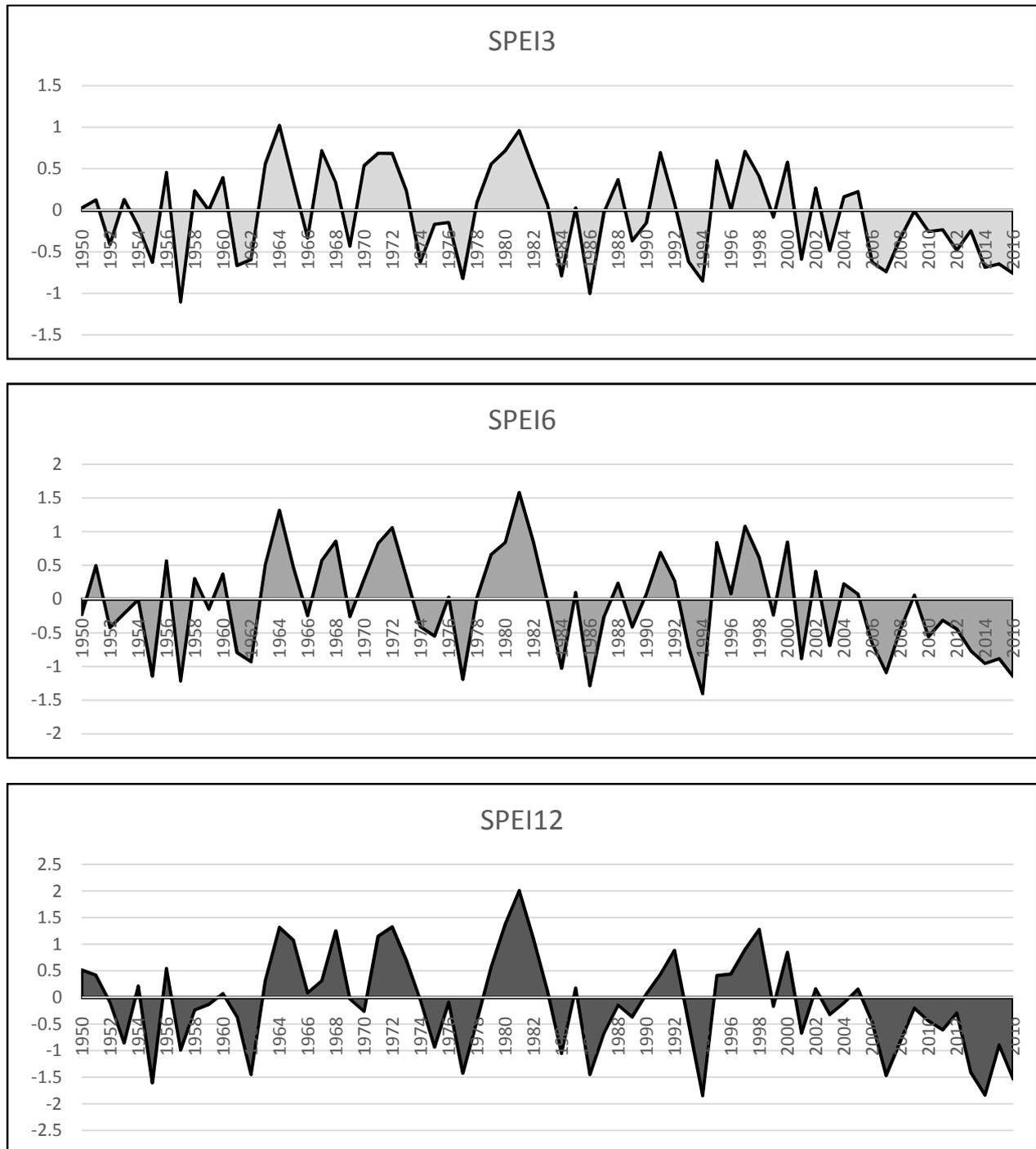


Figure 1. The change of SPEI6 and SPEI12 values between 1950 and 2016 in Bartın region

of climate factors on young individuals should be analyzed and evaluated very well. It is essential that the microecological conditions are handled in detail in the forests. For this purpose, the changes in the number of natural fir youth between the years of 2004-2017 and their relationship with the growth parameters and climate variables were investigated using the models. Thus, the aim of this study was to determine the relationship between climate change and the development of fir youth.

## MATERIALS AND METHODS

**Material:** The research was carried out on the Western Black Sea Fir (*Abies nordmanniana* subsp. *Bornmülleriana* Mattf.) stands in the 23c section of Ardiç Forestry Enterprise Directorate between 2004-2017.

The research area located at the elevation of 1123m., on the upper slope and northwest aspect of that region. The slope is %37.2. The soil is sandy-clayey slip formation and clastic structure. The absolute soil depth is 117m., and the physiological soil depth is 110m. The amount of organic matter is sufficient in the soil. It's a selected forest which has a rich structure to the upper layer in terms of its features. However, the distribution of the number of trunks between the diameter levels is irregular (Anon., 2012-2013). The research forest have the Western Black Sea sub climate type, and average temperature of 20.6°C, annual precipitation of 1054 mm. In 6 months vegetation period.

**Method:** The number of youths, average size growth and average root collar diameters were determined on 10 test areas of 25 x 40m. in the research area. These values are correlated

with the SPEI (Standart Precipitation Evapotranspiration Index) values and effect of drought on various old fir stands has been investigated. The calculation of the SPEI values was carried out using with the R 3.2.2 program (Team R. Core, 2013). SPEI values were calculated as the average of monthly (SPEI1), quarterly (SPEI3), six month (SPEI6) and annual (SPEI12) periods for the period 2004-2017.

SPEI values examined from 1950;

- Severe drought of SPEI12 in 1955, 1994 and 2014.
- Severe drought in 1994, when SPEI6 was the moderately arid 1955, 1957, 1961, 1962, 1977, 1984, 1986, 2001, 2007, 2014, 2015 and 2016.
- SPEI3 has been shown to indicate moderate drought in 1957, 1977, 1986 and 1994. (Figure 1).

## RESULTS

The results obtained from the research are explained in sub-headings below.

**The change in natural youth numbers of Fir:** The results are obtained from experimental areas between 2004-2017 that is showed Figure 2.

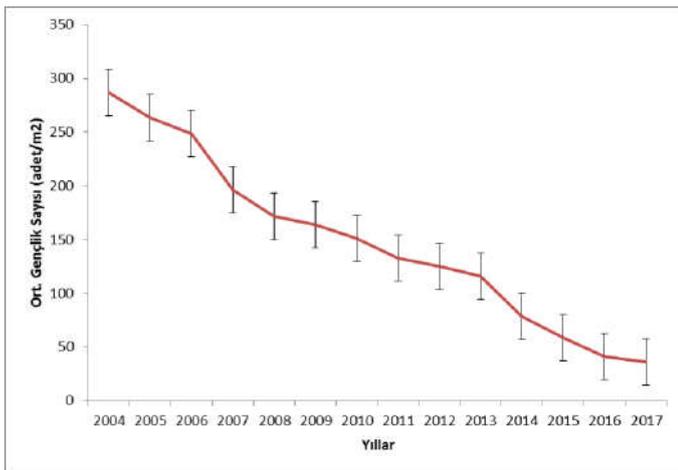


Figure 2. The changes of Fir youths according to years

When the trend curve in Figure 1 examined, it is determined that the average number of youth in square meters varies between 286, 7-36.4. However, the highest decrease in the number of natural youth was observed in 2007 with 20%, in 2014 with 32% and in 2016 with 30%.

**Change of Root Collar Diameter Development of Fir Natural Youth by Years:** Figure 3 shows the status of the change in the mean root collar diameter parameter as a result of the root collar diameter measurement performed on the same youth cores determined in the fir youth determined in the trial areas. When the data in Figure 3 were examined, it was determined that the mean root throat diameter ranged between 1,3-18,7 mm. The lowest increases in the average root collar diameter were in 2007 with 8, 3%, in 2014 with 6, 1% and in 2016 7, 2%.

**Change of Height Growth in Natural Youth of Fir:** The trend curve for the change in average height growth as a result of the measurement made between the years of 2004-2017 in natural youth of fir is given in Figure 4.

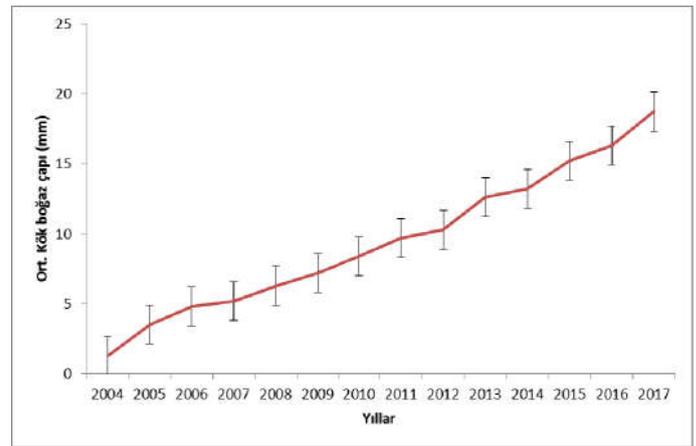


Figure 3. The change of the average root collar diameter of fir natural youth by years

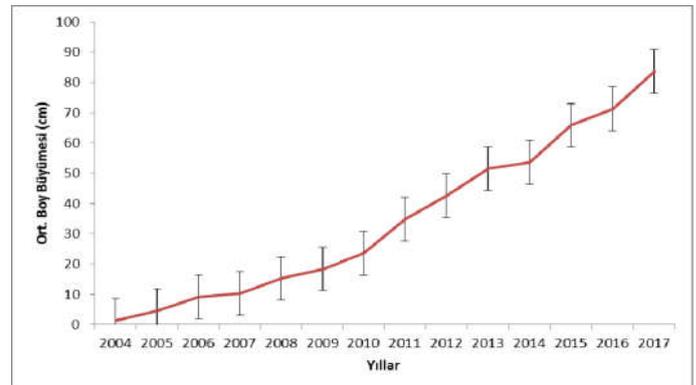


Figure 4. The change of the average growth of the natural youth of Fir in years

According to the data in Figure 3, it was found that the average height growth ranged from 1, 2 to 83,6cm. The periods in which average size growth occurred at the lowest level were determined in 2007 with 11, 9%, in 2014 with 4,2% and 2016 with 8,3%.

## DISCUSSION

In this research, which was carried out between 2004 and 2017 in the fir forests of Ardiç Forestry Enterprise Directorate, it was tried to determine the natural youth dynamics of the Western Black Sea fir. The effects of changes in climatic conditions during the research on global climate change and the number of fir natural youth and their growth performance were determined. It was determined that the average number of youth in the square meter ranged from 286, 7 to 36,4 (Figure 2). According to the results of the counts in 5 different aged fir forests of the Arıt Forestry Region, which was has similar growing of the 8<sup>th</sup> year varies between 145, 3-102, 8 units (Özel *et al.*, 2012). Although it is possible to say that the average number of square meters of natural fir youth in the research area is at a good level as a starting point. But it's worrying about reduction in youth of firs in driest years of the research period 2007, 2014, 2016. The decrease in the number of youth leads to some worries about the future of different stands in the field of research. One of the growth parameters determined during the research in the average root collar diameter. According to this, the average root collar diameter ranged between 1, 3-18,7mm (Figure 3). On the other hand, similar results were obtained in another study conducted in order to determine the diameter distribution of different forests

in the Kastamonu region (Sakıcı et al., 2012). According to these values, the root collar diameter development of fir youth in the research area was determined to be at a good level. The last growth parameter examined within the scope of the research is the average height of the natural youth of fir. As a result of the measurements made in the experiment areas taken from the different aged fir stands in the section 23c between 2004 and 2017. It was found that the average height growth ranged 1,2 to 83,6 cm (Figure 4). In a similar study conducted in the different forests of Arıt Forestry Region, it was found that the average height growth varied between 1, 5-26,9 cm at the end of the 8th years (Özel et al., 2012). Although height growth trends show significant changes depending on the elevation stage and other ecological conditions. The average height growth values of the natural fir youth are good condition in the research area. However, as in the number of youth and the average root collar diameter development, significant growth losses occurred in 2007, 2014, 2016 due to the prolonged dry periods. Özel et al. (2017) conducted on youth of the eastern beech (*Fagus orientalis* Lipsky.) stands in the Kumluca Region. There was found a relationship between the number of youth and SPEI values ranging from 55,6 to 69% in that study. The according to another study it is investigated between pine (*Pinus brutia*) and cedar (*Cedrus libani*), some features of the species (average number of cones, mean chest height diameter, conifer size, conifer moisture, seed sizes in on and two years old cones, female flower counts) whether there is a relationship between drought and male and female flower counts. Varol et al. (2017), found a negative correlation between 40% and 81% in SPEI values and the data obtained from both red pine and cedar seed gardens.

**Recommendations:** According to the results of this study there are found an adverse effects and growth deficits due to climate change and cause to serious danger for vitality for fir stands. Therefore it's been monitored that the growth and growing stages of fir stands. Especially selection method of cuttings are made in right times and technics in the different aged fir stands. It must be protected stand quality, health and stand shelter. Also unexpected drought and freezes must be monitored and evaluated. It is taken into consideration to other works (Özel et al., 2017; Varol et al., 2017).

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